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Data in Brief

Genome wide mapping of Foxo1 binding-sites in murine T lymphocytes

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ARTICLE INFO

Article history:

Received 18 August 2014

Accepted 20 August 2014

Available online 28 August 2014

Keywords:

Foxo1

T cell

ChIP-Seq

ABSTRACT

The Forkhead box O (Foxo) family of transcription factors has a critical role in controlling the development, differentiation, and function of T cells. However, the direct target genes of Foxo transcription factors in T cells have not been well characterized. In this study, we focused on mapping the genome wide Foxo1-binding sites in naïve CD4⁺ T cells, CD8⁺ T cells, and Foxp3⁺ regulatory T (Treg) cells. By using chromatin immunoprecipitation coupled with deep sequencing (ChIP-Seq), we identified Foxo1 binding sites that were shared among or specific to the three T cell populations. Here we describe the experiments, quality controls, as well as the deep sequencing data. Part of the data analysis has been published by Ouyang W et al. in *Nature* 2012 [1] and Kim MV et al. in *Immunity* 2013 [2], and the associated data set were uploaded to NCBI Gene Expression Omnibus.

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Specifications

Organism/cell line/tissue	Murine T cells
Sex	Male or female
Sequencer or array type	Illumina Genome Analyzer IIx
Data format	Analyzed
Experimental factors	Foxo1 antibody and Streptavidin were used for ChIP
Experimental features	ChIP DNAs were prepared from T cells isolated from C56BL/6 mice using Foxo1 antibody and T cells isolated from Foxo1tag/tagbirA mice using Streptavidin-coated beads. ChIP-seq libraries were prepared following a standard protocol.
Consent	N/A
Sample source location	N/A

Experimental design, materials and methods

Mice

Normal C57BL/6 mice and mice containing *Foxo1* knock-in (*Foxo1*tag), *Foxp3*-IRES-RFP and *birA* alleles or *Foxp3*-IRES-RFP and *birA* alleles were previously described [1]. Treg cells in mice carrying the *Foxp3*-IRES-RFP allele were marked by red fluorescence protein (RFP). Foxo1 in mice carrying the Foxo1tag and birA alleles was labeled by biotin. All mice were maintained under specific pathogen-free conditions, and animal experimentation was conducted in accordance with institutional guidelines.

Chromatin immunoprecipitation (ChIP)

CD44[−] CD62L^{hi} naïve CD4⁺ T, CD8⁺ T, and Foxp3⁺ Treg cells were isolated by FACS-sorting, and then fixed for 10 min at 25 °C with 10% formaldehyde. After incubation, glycine was added to a final concentration of 0.125 M to 'quench' the formaldehyde. Cells were pelleted, washed twice with ice-cold PBS and lysed. The lysates were pelleted, re-suspended and sonicated to reduce DNA length to 300–500 base pairs (bp). The chromatin prepared from T cells of C57BL/6 mice was incubated with protein-A-anti-Foxo1 (ab39670, Abcam) or an isotype control antibody overnight. The chromatin prepared from T cells of Foxo1tag/tag birA Foxp3-IRES-RFP or control birA mice was incubated with streptavidin overnight. The immune complexes were washed, and eluted in 500 µl of elution buffer containing 50 mM Tris, 10 mM EDTA and 1.0% SDS. Precipitated ChIP DNA and input DNA were incubated at 65 °C to reverse the crosslinking. After digestion with RNase and

Direct link to deposited data

<http://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE60470><http://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE40657><http://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE46944>

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proteinase K, the ChIP and input DNA were purified with phenol/chloroform extraction and ethanol precipitation. The purified DNA was repaired, ligated with an adaptor, and amplified by PCR for 15–20 cycles. The amplified DNA was purified by gel extraction and used for sequencing. SR-36 sequencing was done at the Genome Center of Cold Spring Harbor Laboratory.

Data analysis

Initial quality control of the sequencing was performed using FastQC (<http://www.bioinformatics.babraham.ac.uk/projects/fastqc/>). After verifying acceptable base calling quality, nucleotide distribution, and adapter contamination, reads were aligned to the mouse mm9 (NCBI, Build 37, July 2007) reference genome obtained through the UCSC Table Browser (<http://genome.ucsc.edu/>) using version 0.12.7 of the Bowtie short read alignment software [3] (<http://bowtie-bio.sourceforge.net/index.shtml>). The parameters “-k 1-m 1” were used to select for only uniquely mapping reads. Peak calling was then performed on the aligned reads. For the CD4⁺ and T_{reg} cell-types, MACS [4] (version 1.4.1, <http://liulab.dfci.harvard.edu/MACS/>) was used to identify putative binding sites. MACS makes use of the inherent tendency of clusters of sense and antisense reads flanking protein-DNA interaction sites to model fragment length. It then considers this estimate when defining windows used to scan the genome for enrichment according to a Poisson distribution. For the analysis of the CD8⁺ data, we developed a novel peak-calling algorithm BCP [5] (<http://rulai.cshl.edu/BCP/>), which employs a Bayesian Hidden Markov model, to perform segmentation of the genome and identify enrichment. This method expands peak-calling capabilities to more diffuse, less punctate enrichment, as seen in many histone modification ChIP-seq and DNase I hypersensitivity sequencing assays. Because BCP does not have an integrated method for dealing with potential PCR duplicates, we preprocessed the read alignments to include only one instance of each unique chromosome start and end position. In both cases, we employed the empirical FDR (eFDR) metric as described by Yong, Z., et al. [4] to minimize false positives. This entailed using the input alignments as the

treatment data and the ChIP alignments as the control to infer the background peak-calling rate. The p-value of peak calling used by MACS or BCP was then adjusted to ensure that the fraction of background peaks divided by called peaks did not exceed the eFDR threshold. This was set to 0.01 for MACS but 0.05 for BCP since, in our experience, it was less sensitive to low density peak false calls. The BEDtools suite of utilities [6] was used for post-processing tasks such as finding overlapping antibody and biotin immunoprecipitated peaks. Visualization was performed using custom R scripts.

Acknowledgments

This work was supported by the Starr Cancer Consortium (13-A123 to M.O.L. and M.Q.Z.), the Rita Allen Foundation (M.O.L.), NIH (AI102888-01A1 to M.O.L. and HG001696 to M.Q.Z.), and NBRPC (2012CB316503 to M.Q.Z.).

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